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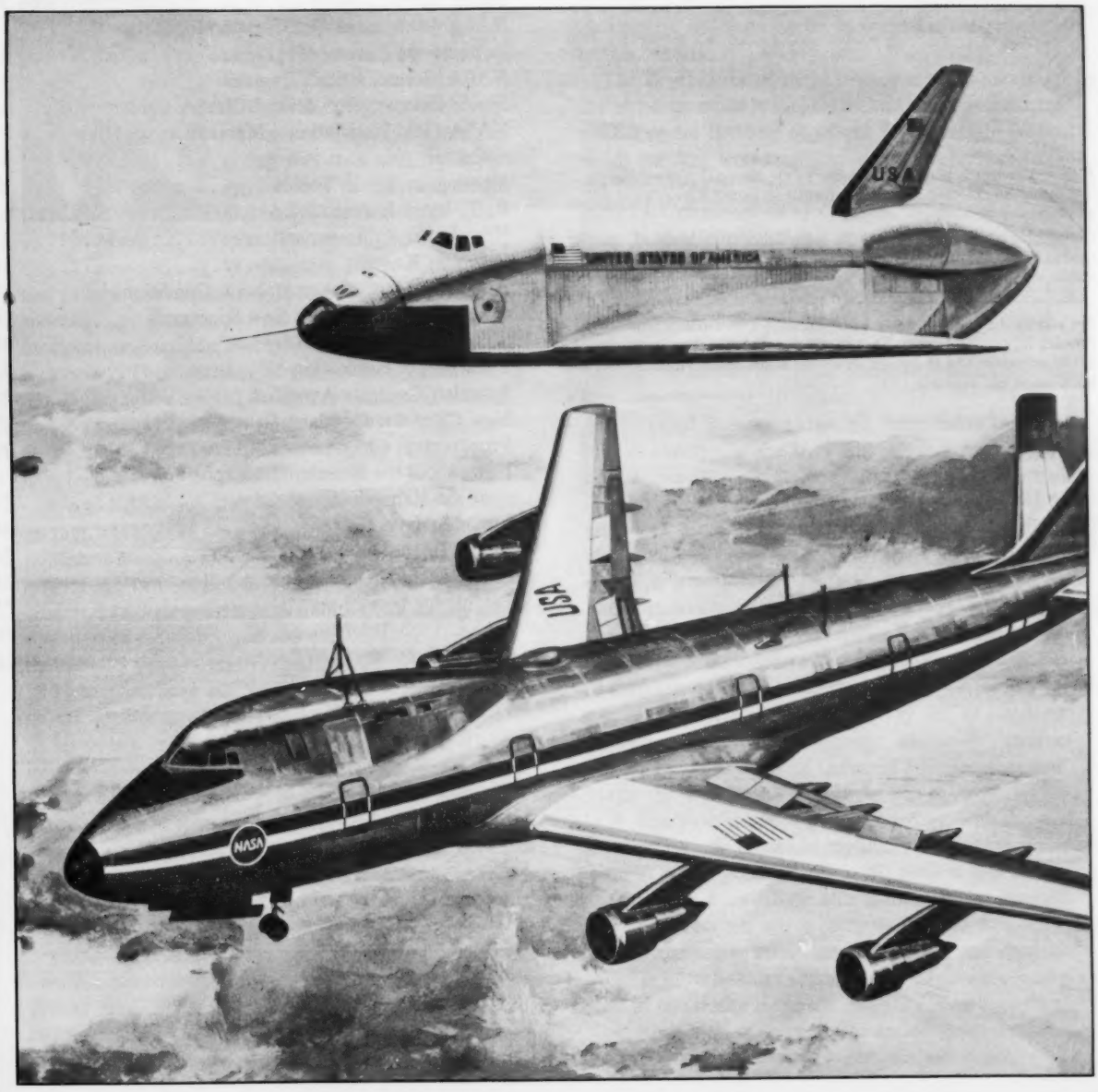

COVER

Space Shuttle Preparations—depiction of the scene when the Space Shuttle Orbiter separates from its carrier aircraft at the start of an approach and landing test. Testing is scheduled to begin in mid-1977 at NASA's Dryden Flight Research Center. The modified Boeing 747 aircraft will carry the Orbiter in piggyback fashion to an altitude of 7,500 meters (25,000 feet), then release it for a glide landing.

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Letter from Washington

"The world is now increasing in experimental knowledge; but let no man flatter the age with pretending we have arrived at perfection of discoveries."

Benjamin Franklin
"Discoveries," 1736

Low

Dear Colleagues:

It was America's good fortune to be colonized during a period when scientific awakening was stirring the western world. Medieval learning, dominated by a fascination for philosophic reasoning and abstract dogma, was giving way to a zeal for experimentation in the physical world. Our early American statesmen-scientists—Franklin, Jefferson, Washington, Rush, Rittenhouse and others—were pioneers in virtually every field of learning: agriculture, archeology, biology, chemistry, medicine, engineering, electricity, mathematics and astronomy. Their discoveries and inventions fostered in our young nation a spirit of science that has flourished under a legacy of self-determined government guaranteeing man's right to life, liberty and the pursuit of happiness.

We at NASA enjoy the unique opportunity of carrying on that tradition of scientific discovery. The recently published *Outlook for Space* and *Outlook for Aeronautics* are two studies that highlight such opportunity. Undertaken during the last 20 months, the studies give direction to our space and aeronautics efforts over the next 25 years. Clearly, these works show that in 240 years we have not "arrived at perfection of discoveries." Nor can we afford to.

These two outstanding studies describe the work that must be done by America's scientists and technologists if we are to maintain our preeminence in the fields of aeronautics and space in an increasingly competitive world. Indeed, as blueprints for our near future endeavors in aeronautics and space, they may represent NASA's most important contribution to our nation's Bicentennial celebration.

Outlook for Aeronautics considers the probable and possible directions of civil and military aviation in the period 1980-2000, the role that NASA should play in aeronautical research and development in this period, and the technical advances that may be required.

Outlook for Space examines future space activities within the context of possible national needs and identifies directions the United States should take in the civilian use and exploration of space for the remainder of this century.

The significance of these studies may be measured by the importance of both aeronautics and space to the vitality of our national economy. Seventy-eight percent of all the free world's transport planes are built in the United States. This amounted to $6 billion in exports in 1975. Contributions to the U. S. balance of payments from NASA's international space programs are expected to total $1.42 billion in the period 1968-78. Looking to the aircraft market of the future, the free world demand for civil aircraft is expected to grow significantly. Sales of subsonic air transports alone represent a market estimated at approximately $50 billion over the next 10 years.

The rapid increase of foreign competition is a most serious concern to the U. S. aircraft industry. With U. S. airlines not currently in a position to provide a stimulus for new aircraft development, U. S. manufacturers must look more to the world market for future sales. The vital factor in competing in this market, 75 percent of which is with non-U. S. customers, will be the continued maintenance of U. S. technological leadership. As today's sales are based on current technology, today's research will be tomorrow's competitive edge.

Outlook for Aeronautics sees NASA's role in having this "competitive edge" as primarily one of conducting applied research and technology. The study identifies the following as areas of technical advancement and major thrust in the next decade:

- Energy-efficient vehicle technology, with the goal of providing the technical capability to develop transport aircraft which consume 40 to 50 percent less fuel than today's fleet. These efforts include aerodynamic design procedures, active controls, laminar flow control, engine and engine component efficiency, and demonstration of technology readiness for large-scale incorporation of composite materials.
- Reduction of undesirable engine emissions, with particular emphasis on stratospheric pollution.

- Propulsion cycles permitting efficient operation over a wider range of flight speeds and altitudes.
- Acceleration and expansion of technology leading to significant improvement in short-range air transportation, specifically the all-weather, quiet V/STOL.
- Acceleration and expansion of the supersonic cruise aircraft research program toward timely technology readiness, emphasizing increased range and payload capability, sonic boom reduction, noise and exhaust emissions reduction, and operating economy.
- Improvement of test facilities and advancement of computational analysis in aerodynamics, propulsion and structures toward the achievement of major savings in vehicle design and development.
- Advanced avionics system technology for improved capability, safety and reliability in Instrument Flight Rules operations, automatic or semi-automatic traffic control, reduced aircraft spacing and active control systems.
- Minimization of wake vortex.
- Reduction in aircraft noise and community impact through optimal flight path control as well as acoustic suppression.
- Improved maneuverability for specialized combat aircraft applications, through advanced configurations and devices to reduce buffet and flow separation at high angles of attack.

The *Outlook for Space* study answers the question, "What are the key roles for space in our national affairs and our national interests?" and identifies some of those possibilities within our reach over the next 25 years.

The focus of NASA space activity over the next decade will center on the Space Shuttle program and the services it will provide. These will range from practical applications which bring everyday benefits to the well-being of humanity, to the exploration of the far reaches of our universe.

The major conclusions of the *Outlook for Space* study are:

- A major increase in emphasis and in resources should be directed toward Earth-oriented space programs.
- Among humanity's needs that are particularly amenable to the use of space-derived data are monitoring and prediction of climate and severe weather, prediction of crop production and water availability, and monitoring of changes to the environment.
- The increasing shortage of available energy warrants an intensive investigation of the technical, economic and environmental feasibility of space power generation and hazardous waste disposal in space.
- The transition between the research and development of space systems for Earth-oriented needs and the operational use of these systems is critical. Planning for this transition should be an integral part of the earlier phase and will require substantial resources.
- The multiple use of operational remote sensing spacecraft will be necessary to economically exploit the utility of the nation's Earth-oriented space program. The development and management of these spacecraft will require broadened and innovative cooperative arrangements between government agencies at the Federal, state and local levels, as well as between government and the private sector.
- The space science program of the future should continue exploratory research but should increasingly be focused on specific objectives selected on the basis of their expected contribution to fundamental scientific questions.
- Scientific questions of particular current significance deal with the beginning of the Universe; the nature of black holes and quasars and gravity; the evolution of the planets and their atmospheres; the nature of the Earth's climate; and the search for extraterrestrial life, including intelligent life.
- Social, economic and technical forces will one day cause man himself to further explore and exploit the solar system.
- A major increase in attention and resources should be directed toward data management and information extraction.
- There should be increased emphasis on theory, development of predictive modeling and data analysis in support of future space missions.
- The United States needs to maintain its international leadership in space communications and, therefore, should increase its efforts to advance communications technology and to develop and demonstrate new uses.
- An active program should be pursued to exploit the zero-gravity environment of space to increase the understanding of material science and basic physical, chemical and biological processes.
- The United States should develop a permanent Space Station to fully exploit the zero-gravity environment of space for basic research, to develop a full understanding of the ability of man to live and work in space for extended periods, and to provide a potentially useful instrument of U. S. foreign policy.

Such initiatives will not come easily. They will require a renewal of commitment—the courage and confidence that we can define our own purpose and shape our own destiny. This, I believe, would please Dr. Franklin.

Sincerely,

George M. Low

Monthly NASA Highlights

Communications Satellite Launched

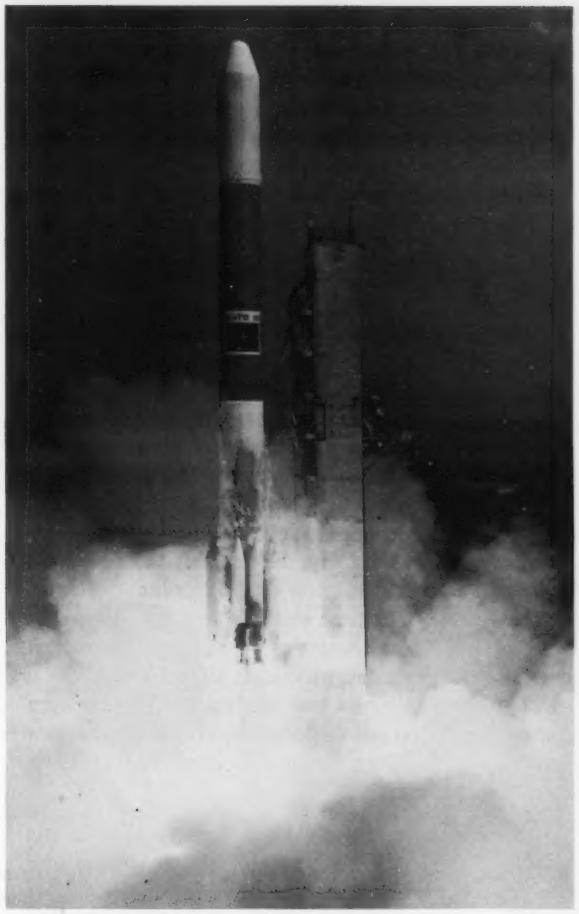
NATO IIIA, the first in a new series of military communications satellites to serve the North Atlantic Treaty Organization, was launched successfully by a Delta 2914 launch vehicle by the Kennedy Space Center from Cape Canaveral April 22. All spacecraft systems are functioning properly. The spacecraft apogee kick motor was fired at fifth apogee to circularize its orbit in synchronous orbit 36,000 kilometers (22,300 miles) above the equator over the Atlantic Ocean.

Two NATO spacecraft were launched by NASA previously, in March 1970 and in February 1971.

The NATO IIIA will be used to transmit voice, data, facsimile and telex messages among military ground stations. The drum-shaped spacecraft is about 2.2 meters (86 inches) in diameter, 2.23 m. (88 in.) long, with an overall length of about 3.1 m. (122 in.) counting the antennas. It weighs 720 kilograms (1,540 pounds) at launch, 310 kg. (677 lbs.) thereafter. Its design lifetime is seven years.

NASA's Goddard Space Flight Center provided the Delta vehicle to launch the satellite. Aeronutronic Ford Corp. built the spacecraft and McDonnell Douglas Astronautics Co. manufactured the Delta. The entire program is in behalf of the NATO Integrated Communications Systems Management Agency.

Subsequent plans are to launch a NATO IIIB spacecraft later this year into synchronous orbit over the Pacific Ocean.



Launch of Military Communications Satellite—On April 22 at 3:46 p.m., NATO-IIIA was launched for the North Atlantic Treaty Organization. It hovers above the equator in the Atlantic Ocean at 15.5 degrees west longitude, due south of the westernmost coast of Africa.

Secretaries Week at NASA Headquarters

The week of April 18 to 24 was Secretaries Week throughout the United States and Canada and was celebrated in a two-day program at headquarters.

The NASA Secretaries Advisory Council presented an exceptional program of information and education in honor of the agency's secretarial and clerical employees, which was attended by all categories of NASA employees. The theme of the program was "Career Enhancement—Avenues for Growth and Keys to the Future." Career counseling was featured, and sessions were held on word processing, the certified professional secretary, Federally employed women and the Federal Women's Program.

Administrator James C. Fletcher said: "I am certain that all members of the NASA staff are pleased to join me in extending a well deserved tribute to all our

secretaries and clerical personnel who help make possible our agency's goals. We all join in saluting them during Secretaries Week of 1976."

He added that the purpose of designating a special week to recognize these extremely useful people is to draw attention to their contributions to the educational, business and civic growth of the community.

Oceanic Waters Are Studied by GEOS-3 Satellite

A NASA-Navy team of engineers, technicians and scientists from NASA's Wallops Flight Center and the Naval Research Laboratory have returned from an expedition to Newfoundland where ocean surface conditions were measured simultaneously from an aircraft and from the GEOS-3. The purpose of the mission was to obtain measurements of actual surface conditions through use of instruments aboard the Naval aircraft, then correlate the data with the remotely sensed information acquired by an altimeter on the satellite.

The GEOS-3 altimeter was operated over a major portion of the North Atlantic, including Newfoundland, eight to ten times a day, producing 10 to 15 minutes of data during each pass over the region. The data were transmitted to stations at Bermuda, Winkfield (England) and Madrid, then retransmitted to computers at the Goddard Space Flight Center, which produced estimates of the sea state observed by the satellite. The sea state values were plotted for the North Atlantic and a composite map was made for each day. The maps were compared with data from aircraft and with Navy/National Oceanic and Atmospheric Administration's forecast maps, which also were produced daily.

The surface truth mission provided wind field maps, cloud cover data, atmospheric refraction profiles and sea-surface wave conditions for a selection of GEOS-3 overpasses. Data obtained from aircraft measurements were used to analyze the various error sources that influence the spacecraft altimeter measurements and to demonstrate that the satellite altimeter can function as an oceanographic sensing system.

Newfoundland was selected as the experimental site because of the wide range of climatic and oceanographic conditions that prevail during relatively short periods. It is essential that surface truth operations be performed in such regions.

Freshly Decorated NASA Plane—The NASA 1 aircraft recently acquired a new paint job that conforms to the agency's unified visual communications system. It features a simple tri-color combination of white, blue and silver/gray. The agency logotype appears on the vertical stabilizer in "NASA red" against a white background. Plans are underway to unify the basic paint scheme for all NASA-owned aircraft as planes become due for repainting.

Scientists Explain Space Objectives

The Office of Space Science conducted an outstanding presentation for NASA headquarters employees in mid-April. Dr. Noel W. Hinners, Associate Administrator for Space Science, was in charge of the program, presenting an overview of the space science program and introducing the speakers.

Dr. Robert Jastrow talked about the "Riddle of Creation." He discussed present and past theories about the Universe, what information mankind is seeking, and why it is important. Dr. Jastrow, director of the Goddard Institute for Space Science since it was established in 1961, is an adjunct professor of geophysics at Columbia University where he received his Ph.D. in physics. He is the author of "Red Giants and White Dwarfs."

Dr. Gerald A. Soffen discussed the Viking Program, presented a preview of the objectives and capabilities of the Viking spacecraft, and summarized the anticipated results and the importance of the Viking landing on Mars. Dr. Soffen, project scientist for the Viking Program at the Langley Research Center, holds degrees in zoology, biology and physics.

Medical Advances Resulting from Space Experiments

Dr. David Winter, director for Life Sciences at NASA, addressed the Cleveland, Ohio, medical community recently at a Washington, D.C. reception. He delineated the medical advances that have come about in recent years as a result of space research. Among other developments on a long inventory, he mentioned:

- The benefits heart disease victims have realized because of the cardiac pacemakers. Pacemakers essentially are pressure sensors like those used on the wings of model planes in wind tunnels, which are inserted in the heart to monitor blood pressure.
- Space suits with a controlled environment—like the ones developed for the astronauts—which help children who are born without an ability to fight infection. By donning an adaptation of the space suit, the child can move about freely in a sterile hospital room.
- Wheelchair attachments for quadriplegics, which free them from bed confinement. An eyeglass attachment on the wheelchair enables a patient to move about by eye movements which transmit commands through the glasses; also a voice command unit attached to a wheelchair, which enables a patient to give voice commands for various movements.

Director Named to Top Technical Group

Dr. Bruce T. Lundin, director of NASA's Lewis Research Center, has been elected to the National Academy of Engineering (NAE), considered the highest professional distinction that can be conferred on an engineer.

Election ceremonies took place at the Academy's 12th annual meeting in Washington, D.C.

Dr. Lundin was elected principally because of his outstanding leadership in aeronautical propulsion research and launch vehicle development.

NAE is a private organization established in 1964 to share in the responsibility given the National Academy of Sciences to advise the Federal Government, on request, in matters of science and engineering; to sponsor engineering programs aimed at meeting national needs; to encourage engineering research; and to recognize distinguished engineers. ■ ■ ■ ■

Award for Firefighting Equipment—Louis Mogavero (left), director of NASA's Technology Utilization Office, presents Roy Bivins with the Johnson Space Center Group Achievement Award for his work as a member of the NASA Firefighter's Breathing System development team. Bivins established the program that led to development of a new, lightweight firefighter's breathing system featuring improved face mask, lighter air bottles and a better mounting harness. The system was the first major improvement in firefighting air-breathing equipment in 20 years. The NASA-developed system is being produced by Scott Aviation, a division of A-T-O Company, Lancaster, N.Y. The first commercial units will be delivered to the Boston Fire Department.

PROSPECTUS

Why NASA?

"Prospectus" is a series of articles written for NASA Activities to bring to readers a comprehensive overview of NASA's past accomplishments, present activities and future goals, and how they may affect all our lives. This month's article, "Why NASA?", deals with NASA's origins as our Federal government's major research and development agency.

For most Americans, the Space Age began almost 20 years ago on Oct. 4, 1957, when the Russians launched the Earth's first artificial satellite, Sputnik 1. The challenging idea that man was not forever destined to be Earthbound, however, was born much earlier in this century when the Wright brothers, on Dec. 17, 1903, flew the first airplane a distance of 38 meters (120 feet) on Kill Devil Hill near Kitty Hawk, N.C.

It is the latter date and the few years following that are of such significance to NASA, for it was during that time that NASA's heritage was being created by a small band of enthusiastic scientists and inventors.

Whereas it took a Sputnik to galvanize the American scientific and political communities into creating NASA in the late 1950s, the threat of foreign dominance of the air and World War I combined to move President Wilson and Congress to create NASA's predecessor agency, the National Advisory Committee for Aeronautics.

The Age of Air Flight Begins—One of the few existing pictures of Dr. Samuel P. Langley (right), third Secretary of the Smithsonian Institution, with pioneer mechanical engineer Charles M. Manly. Photo was taken just before the disastrous launch in 1903 of the Langley-designed "Aerodrome"—a glider fitted with a small internal combustion engine. The craft flew only a short distance on its trial flight, with Manly acting as pilot, before crashing into the water. Years later its engine was recognized as a major step toward modern principles of air flight. The trial flight took place nine days before the Wright brothers made their successful flight at Kitty Hawk.

The Creation of NACA

After 1910, the mounting tension of approaching war stimulated aeronautical development in Britain, France, Germany, Austria, Russia and Italy. Scientists, engineers and industrialists were encouraged by their governments to devote their skills and resources to the new art. European progress was rapid and, at times, spectacular.

In Europe there was a quick recognition of the gains to be made from aeronautical laboratories staffed by competent engineers, but the development of the airplane in the United States was dependent largely upon the efforts of a host of amateur inventors. The European nations all had laboratories engaged in aeronautical research, but the U.S. had no comparable effort. True, the Army Signal Corps bought a few airplanes in which pilots were trained, and the Navy set up a flying school equipped with Glenn Curtiss seaplanes. But when World War I erupted in 1914, France had 1,400 planes, Germany 1,000, Russia 800, Great Britain 400 and the U.S. only 23!

Two men, Alexander Graham Bell and Charles D. Walcott, were influential in establishing a national aeronautical laboratory in this country. Bell, as a regent of the Smithsonian Institution, had been a supporter of Samuel Pierpont Langley's aeronautical research and had experimented with the lifting capabilities of kites.

Dr. Walcott was no aeronautical scientist. His field was geology. But Dr. Walcott, successor to Professor Langley as Secretary of the Smithsonian, was determined that the Institution should resume its position as a leader of aeronautical science in America.

Despite their efforts, as well as pressure from the National Academy of Sciences, Washington approval was not forthcoming for the creation of a Federally funded aeronautical laboratory. It was not until the outbreak of World War I, a dozen years after the Wright brothers first achieved practical manned flight, that legislation creating the NACA was added as a rider to the Naval Appropriations Act of March 1915.

NACA was ". . . to supervise and direct the scientific

The next "Prospectus" will deal with the creation of NASA and highlights of its early years.

study of the problems of flight, with a view of their practical solution." The members of the National Advisory Committee were representatives of the military and naval air services, the Weather Bureau, the Smithsonian Institution and the scientific community. They served without compensation. "The sum of $5,000 a year, or so much thereof as may be necessary, for five years" was appropriated by the Congress for NACA. The first meeting of NACA was held on April 23, 1915, called at the direction of President Woodrow Wilson by the Secretary of War.

NACA served as a focal point for defining and solving crucial policy problems and assigning research tasks during the first world war. It made important recommendations on cross-licensing of patents, on air mail and on aircraft production.

The most important part of NACA's advisory services during its first 10 years was its leadership in efforts for legislation necessary to the orderly development and and growth of civil aviation. Such legislation was finally realized with the passage of the Air Commerce Act of 1926, eight years after NACA had recommended "Federal legislation . . . governing the navigation of aircraft in the United States and including the licensing of pilots, inspection of machines, uses of landing fields, etc. . . . designed to . . . encourage the development of aviation . . ."

The Air Commerce Act made the Secretary of Commerce responsible for the regulation of civil aviation and for its encouragement. At the same time, this action freed NACA from its "advisory" burden of those early years. From then on, NACA could concentrate on its chief responsibility—the conduct of aeronautical research. The first NACA laboratory facilities were at Langley, Va. Other experimentation took place at the Navy Yard in Washington, D.C., McCook Field in Dayton (Ohio), Leland Stanford University and the Massachusetts Institute of Technology.

During World War II, NACA was plagued by the necessity for rapid expansion of the civil-service staff, from only about 500 in 1939 to more than 6,800 in the subsequent five years. Trained engineers were unavailable. Consequently, it was mandatory that professionals be spread thin—loom fixers, toymakers, mechanics, blacksmiths and women school teachers were recruited for jobs they could do or for which quick instruction could be given.

NACA's war effort was of necessity devoted largely to applied research, the business of finding "quick fixes" to make existing aircraft better performers, and production engines more powerful. Fortunately, a considerable backlog of design data were available for application to such subjects as low-drag wings, high-speed propellers, stability and control, and improved systems for cowling and cooling engines. Between December 1941 and December 1944, the Committee's research centers worked on 115 different airplane types. In July 1944, 78 different models were under simultaneous investigation.

The end of World War II marked the end of the development of the airplane as conceived by Wilbur and Orville Wright. The power available in the newly developed turbojet and rocket engines for the first time brought within man's reach flight through and beyond the speed of sound and into outer space.

After World War II, the U.S. began scientific probing of the upper atmosphere with V-2 rockets, and later with the Aerobee and Viking sounding rockets. Rocket technology that made space exploration practical derived directly from the accelerated military missile programs that grew out of the "cold war" of the 1950s. Until Sputnik 1, however, military security requirements for operational intercontinental ballistic missiles with nuclear warheads received highest priorities and support in the U.S. After Sputnik 1, it was clear that the U.S. must pursue a sound long-range space program for its own sake, that space exploration had vital scientific and technical implications of far-reaching future significance.

The first U.S. earth satellite program, initiated in 1955 as part of the International Geophysical Year (IGY), was called Project Vanguard. Although judged by many Americans as a post-Sputnik propaganda failure, it actually proved to be a scientific and technological success. Explorer 1, the first U.S. satellite, was successfully launched into orbit from Cape Canaveral by the Army Ballistics Missile Agency on Jan. 31, 1958. It carried an IGY experiment, originally intended for Vanguard, provided by Professor James A. Van Allen of the University of Iowa, and made the most important discovery of the IGY—the radiation belts that carry his his name. Vanguard 1, first with solar-powered batteries, was launched on March 17, 1958 and, because of its eccentric orbit, made numerous scientific contributions related to solar pressure and the shape of the Earth.

NASA Awards Exceed $1 Million

When monetary awards of $121,925 given in Fiscal Year 1975 were added to those made under the Monetary Awards Program in previous years, the total amount of awards granted since NASA's inception reached $1,040,000.

The Inventions and Contributions Board recommends monetary awards to be granted by the Administrator or his delegee, the Assistant Administrator for Industry Affairs and Technology Utilization. The program is administered by NASA's Inventions and Contributions Board in accordance with the provisions of the National Aeronautics and Space Act of 1958.

With a few exceptions, the awards have been granted to NASA employees and contractor employees for, as stipulated in the Space Act, "any scientific and technical contribution to the Administration which is determined by the Administrator to have significant value in the conduct of aeronautical and space activities."

A breakdown of the grand total of $1,040,000 reveals that $565,000 was awarded for significant inventions and scientific contributions; $166,000 for contributions and innovations published as NASA *Tech Briefs* that emanated from the Technology Utilization Program; and $308,000 (FY 1963-69) to NASA and oher U.S. Government employees by special arrangements under the authority of the Incentive Awards Act.

The first major award made by the Inventions and Contributions Board was in 1961 to Dr. Frank T. McClure of Johns Hopkins University for his invention entitled "Satellite Doppler Navigation System."

During the first half of FY 1976 (ending Dec. 31, 1975), additional awards amounting to $72,250 were recommended by the Board, including two major awards of $15,000 each—one to Francis T. Bacon, and one to Robert T. Jones. Thus, as 1976 began, more than $1,110,000 in award money had been distributed under the NASA Monetary Awards Program.

Space Age Glassware

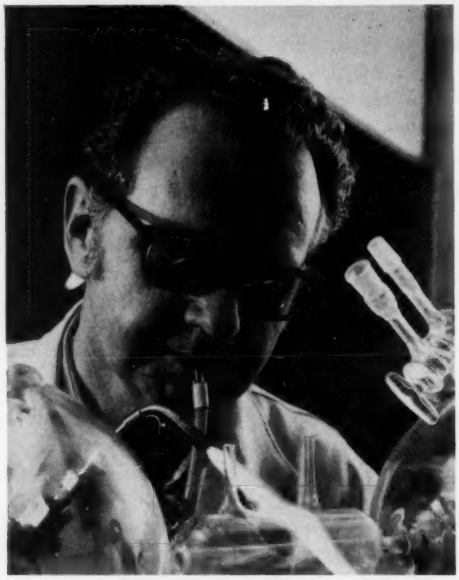
Glassblowing is not the kind of craft one would ordinarily associate with the sleek, world-of-the-future ambience that marks many NASA establishments. It is, however, one of the many vital small cogs that help to keep the NASA research program in good working order.

Don Moody, chief experimental glass fabricator at NASA's Ames Research Center, practices his old-fashioned trade in a gleaming modern workshop, producing a wide variety of glass tubes, rods, globes, and other objects in all sizes and shapes. His exacting job is to tailor glass articles to meet the specific needs of the advanced research conducted at the Ames laboratories. One day he might be manufacturing a vial with a flat "window" through which scientists can photograph the contents without distortion, another day a bonded metal-glass container in which green beans will be grown as a potential food item for space travelers.

Moody's mode of glassblowing is different from the most familiar kind, in which a craftsman shapes a glob of glass by blowing air through a tube held in his mouth. Instead, in a system developed on the job (training courses for scientific glassblowers are almost non-existent), he secures a tube of glass in a lathe and, while the tube rotates horizontally, applies a torch to specific parts. When the material starts to glow and melt, Moody blows lightly through a flexible tube connected with the machine. The glass bulges. He shoves the left end an inch toward the right and a bubble is cupped. The first chamber of what is to become an oil condenser thus is shaped.

When the torch work is completed, the item must be held in an oven for a time to allow the strained glass molecules to relax in their new forms. Too rapid cooling can result in shattered glass.

Moody began his career at Ames in 1949 and took over as resident glass fabricator in 1954. Training for the work consisted of high-school courses in machinery and craft courses at San Jose State University.



Tailored Glass for Science—Don Moody creates one-of-a-kind glass objects for scientific programs carried out at NASA's Ames Research Center. A former machinist, Moody picked up his glassblowing skills as he went along. He says: "Two things are easy to learn about glassblowing—how to cut yourself and how to burn yourself."

NASA Astronomer Gets Fourth Honorary Doctorate

Roman, with model of OSO.

Dr. Nancy G. Roman, Chief of Astronomy and Relativity Programs for NASA, was awarded an honorary Doctor of Science degree by Swarthmore College (Pa.) on May 24. She won her B.A. at the same college 30 years ago, her Ph.D. at the University of Chicago in 1949. No stranger to academic award platforms, Roman was similarly honored by the Russell Sage College (N.Y.), Hood College (Md.) and Bates College (Me.) in the five years between 1966 and 1971.

She described her latest honorary degree as especially rewarding, coming as it does from her Alma Mater. "I'm extremely honored and pleased to be given the degree from Swarthmore," Roman said. "I have always had a deep and abiding respect for the college, which has remained uncompromisingly faithful to its high academic ideals."

One of the world's leading astronomers, Roman joined NASA in 1959 as head of the Observational Astronomy Program. In her present post, she is responsible for the planning, coordination and initiation of a comprehensive program of astronomical observations conducted by means of aircraft, balloons, rockets and satellites. She has played a major part in the planning of most of NASA's astronomical research—on Earth and in space. This includes such landmark projects as the Orbiting Solar Observatories, the Geodetic Satellite and the first gamma-ray satellite.

Roman was one of three Americans invited by the U.S.S.R. Academy of Sciences to attend the dedication of the Bjursken Astrophysical Observatory in Soviet Armenia in 1955. She has observed astronomical phenomena with telescopes at various observatories in the United States, Canada and Chile.

The NASA astronomer is the recipient of numerous honors for career achievements, including the Federal Women's Award and the NASA Exceptional Scientific Achievement Award. She was a nominee for a "Woman of the Year" award last April. Roman was elected a Fellow of the American Astronautical Society in 1975.

NASA Honors British Engineer

Francis T. Bacon recently was presented with a major award by NASA—a $15,000 check and a NASA Certificate of Recognition. American Ambassador Anne Armstrong made the presentation at ceremonies held at the U.S. Embassy in London. Bacon is a direct descendant of the eminent 17th century philosopher and natural scientist of the same name.

The award to Bacon was recommended by NASA's Inventions and Contributions Board and granted by the Administrator as authorized by Section 306 of the Space Act. It was made in recognition of his invention, development and practical demonstration of the "Bacon Hydrogen-Oxygen Fuel Cell Technology" for the generation of electricity. The technology was selected by NASA to be the basis for the on-board electrical power system for the Apollo program.

After modification and adaptation of the Bacon fuel-cell technology for spacecraft by NASA and its contractors, a standard power plant unit was produced which was subsequently installed on the spacecraft used on all Apollo missions, all Skylab missions and in the Apollo Soyuz Test Project. In every instance, the power plant units incorporating the Bacon fuel-cell technology performed flawlessly, and all manned mission electrical power requirements were satisfactorily fulfilled.

This is the first time a major Space Act award has been granted to a foreign citizen not previously employed by NASA or a NASA contractor. Bacon conducted the research and experimental investigations that led to the development of the successful fuel-cell technology while employed by Cambridge University and the National Research Development Corp. of Great Britain. He is the recipient of numerous honorary awards, including the Order of the British Empire, and is presently living in retirement in Cambridge, England.

Major Award to Briton—Standing before a portrait of Sir Winston Churchill, Mrs. Anne Armstrong, the U.S. Ambassador, presents a check and a certificate of recognition from NASA to Francis T. Bacon at the U.S. Embassy in London. Bacon, a British inventor and engineer, received the award for his successful development of fuel-cell technology used in the U.S. manned space program.

Movie Extravaganza Shot at NASA Center

The Johnson Space Center was the setting during the month of March for a Hollywood sci-fi film—"FutureWorld," sequel to "Westworld"—to be released in July, perhaps on July 4.

As Public Affairs writer Charles Redmond put it in a recent issue of the JSC publication, *Roundup*: "For 30 days and 30 nights they were here [producers, directors, actors, photo crew, special effects people, stagehands, technicians, stunt men, relatives and friends]. And when the result is released, American International Productions will show how Hollywood can take a nice, quiet, suburban government installation and turn it into Delos—the resort of the future."

He added that before the film was completed, it had become more like a space mission to the several contractors and dozen-or-so NASA divisions involved than the non-interference, no-cost activity it started out to be.

Shooting schedules coincided with downtime for many of the JSC facilities to be used, however, the script was appealing, and the movie-makers were prepared to contribute more than $1 million to the Houston economy, so NASA officials responded favorably to Texas Governor Dolph Briscoe's request for cooperation.

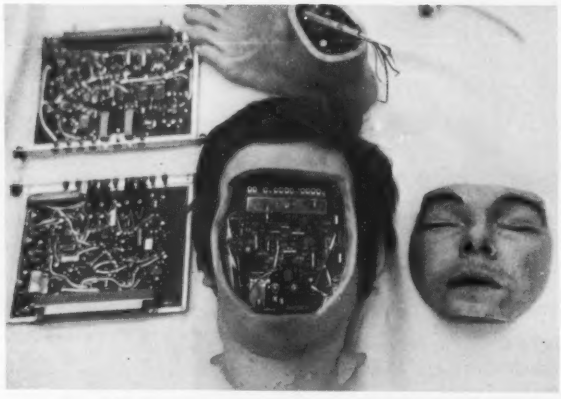
The cast of characters for "FutureWorld" includes Peter Fonda, Arthur Hill, Blythe Danner (heroine), John Ryan, Stuart Margolis, Yul Brynner (in a cameo appearance) and 700 beautiful girls who pretend to be robots.

The plot involves two journalists on the trail of a mysterious situation apparently centered in an amusement park called Delos, where people pay $1,200 a day to make wild dreams come true. The various fantasylands in Delos cover a wide variety of tastes—from a "Medieval World" where maids of honor vie for one's pleasure (this is where the 700 beautiful "robots" come in) to skiing on the red slopes of Mars or playing golf on the moon. But somewhere between Delos' entrance and exit gates, an odd kind of transformation happens to the guests, and therein lies the mystery to be unraveled by the journalists.

Filming began with the arrival at JSC of a seemingly endless caravan of trailers, generators, trucks, vans, cars and hangers-on. Special power arrangements had to be made to handle the strange lighting and sound effects; a forest of structures sprang up made of chrome, steel, plexiglas, fake computers and the like in one of the JSC buildings; the Skylab workshop became the scene for launches; one bulding was rearranged to accommodate filming of scenes with the girl-robots; another was the setting in which humans were turned into robot-like creatures call clones; and the famed Mission Control Center temporarily became Robot Control Center. Crowds of curious observers on hand throughout the filming increased greatly for one sequence when the day's shooting called for a stunt man to fall 50 feet to his death—actually onto an inflated air mattress. (The scene was successfully filmed on the first take.) Another exciting day saw a fight by a horde of Samurai warriors who chased each other through a network of pipes and hyperbaric chambers.

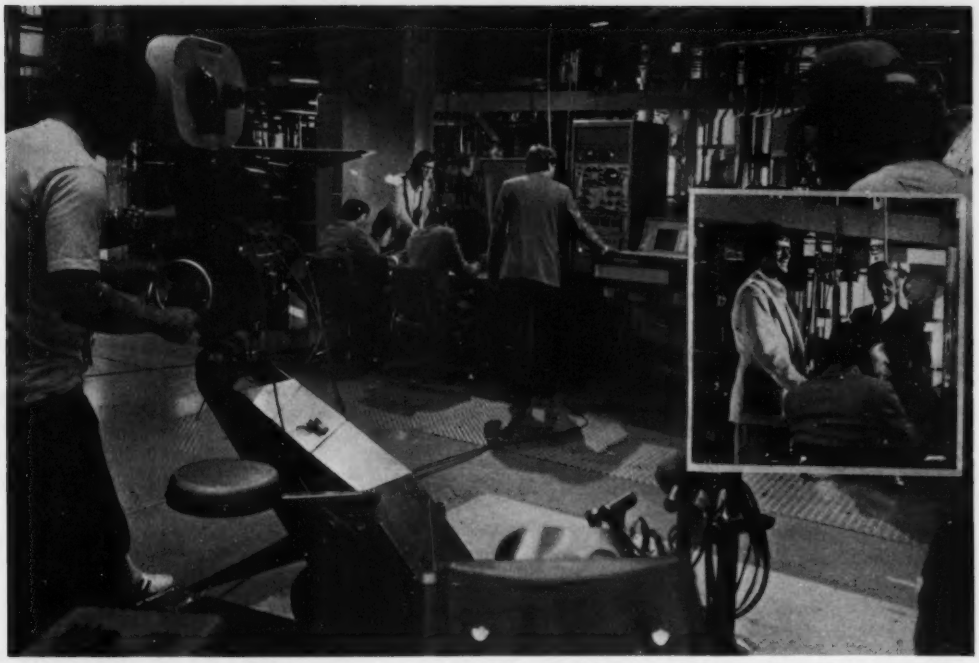
By the end of March, the NASA employees at JSC knew a lot more about movie-making than they had ever anticipated; and the Hollywood people and their families, fascinated by their temporary environment, had repeatedly toured the NASA facility. But despite the excitement and confusion generated by the cinematography, work schedules at the space center suffered no serious interruptions. NASA people were able to take the hectic month in stride.

"Future World," incidentally, will have a "PG" rating.



Getting It All Together—Robot spare parts laid out on an "operating table," ready for assembly during filming of "FutureWorld" at JSC. The anatomical sections are filled with remains of outdated (but genuine) model computers.

Skylab Equipment Reactivated—Inside JSC's building 5, Hollywood extras sit inside the Skylab 1 trainer awaiting filming of scenes in "FutureWorld." The top level of the building was used as the stage for simulated rocket launches during filming.



Science Fiction Comes to NASA—A soon-to-be-released motion picture used Johnson Space Center facilities to achieve realism in scenes depicting a spaced-out situation. This scene was filmed in JSC's building 32, chamber B area—the Space Environment Testing Building. Inset photograph shows stars Peter Fonda (left) and Arthur Hill (facing camera).

New Look for Space Laboratory—The anechoic chamber at JSC's building 14 was converted into the "cloning room" where robots slowly acquire human awareness and characteristics identical to those of the person they will replace in the motion picture "FutureWorld." Cones on floor, wall and ceiling are microwave attenuators affixed to sound absorbent walls designed for acoustic measurements. Aluminum cones are courtesy of Hollywood.

This is the third in a series of profiles of NASA field centers.

NASA Field Installation
Marshall Space Flight Center
Huntsville, Alabama

Departing from its stance of a decade ago when most of its efforts were dedicated to the Saturn program, the Marshall Space Flight Center has become a multi-project scientific and engineering organization that supports the various program offices of NASA, as well as other Government agencies.

Most of the center's work presently is directed toward development of space carriers designed to make up the Space Transportation System. A greatly diversified group of scientists and engineers at the center is helping to build the Space Shuttle as the rocketship of tomorrow, planning the Shuttle interim upper stage and the Space Tug, helping to develop the Spacelab and planning and integrating its payloads. MSFC personnel also manage the development and launch of small payloads such as Lageos, Gravitational Redshift Probe, and the High Energy Astronomy Observatories on Atlas-Centaur rockets, and devise means by which solar energy usage can be increased.

Named by President Eisenhower for the soldier-statesman-humanitarian General George C. Marshall, the center was officially dedicated by President Eisenhower on Sept. 8, 1960, with Mrs. George C. Marshall attending the ceremony.

The founding director of the center was Dr. Wernher von Braun, who guided the organization's growth and development into an efficient management and technology center that provided the launch vehicle to carry out President John F. Kennedy's mandate to land a man on the Moon and return him safely to earth by 1970.

The expertise that was developed in building Saturn launch vehicles for the Apollo, Skylab and Apollo Soyuz Test Project has been diverted to the design and development of the main engines, solid rocket booster and external tank for the Space Shuttle, the basic vehicle in the Space Transportation System (STS).

As lead center for NASA in a cooperative venture with the European Space Agency, the Marshall Center is working directly with several European countries to assure that all requirements are met in the design and development of Spacelab, a vital component of the STS. MSFC also is the lead center in the representation of NASA's interest in development by the Department of Defense of the Interim Upper Stage, scheduled for inclusion in Shuttle missions in mid-1979.

A Spacelab Payload Project Office has been established to carry out the assignment—by the Office of Space Science—of managing projects involving Spacelab payloads.

Several payloads for exploring and using space are managed by MSFC. These include the High Energy Astronomy Observatories, to provide a better understanding of energy sources in space; the Gravitational Redshift Space Probe to test Einstein's theory of rela-

Broad-based NASA Center—The Marshall Space Flight Center is located on 1,800 acres in the midst of the U.S. Army's Redstone Arsenal in Alabama. This aerial view, looking east, shows the three-building headquarters complex which houses many of the NASA employees. Other units of MSFC are at Slidell and Michoud, Louisiana.

Historical photograph, taken in 1969—Dr. Wernher von Braun (in swim trunks), first director of MSFC, demonstrates usage of a camera under simulated weightless conditions. Scientist Dr. Jacques Piccard watches. The men were in the Marshall center's neutral buoyancy simulator. Von Braun's feet are anchored by a "Dutch Shoe," which is built on top of a mockup of the NASA Apollo Telescope.

tivity; and the Laser Geodynamic Satellite, which will measure Earth movements.

The Space Telescope, presently in the definition phase, will allow scientists to look at the outermost limits of the Universe. If the project moves into the development and production phase as currently planned, the telescope is expected to be launched by the Space Shuttle in the early 1980s.

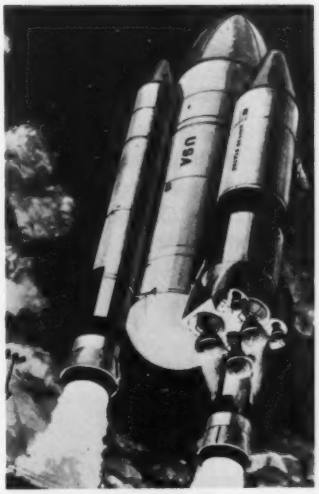
The Space Station, now in the concept definition phase, will serve as an operational base in space and as a space laboratory. MSFC and the Johnson Space Center are conducting parallel systems analysis studies to define and analyze concepts of Space Station facilities for low and synchronous altitude Earth orbit, including orbit-to-orbit transportation.

Large structures in space are foreseen for the future. These projects will make use of the Space Station to fabricate and assemble structures such as Satellite Power Systems and other large structure projects.

The Satellite Power System is envisioned as a series of satellites drawing energy from the Sun and converting it into electricity to be beamed by microwave to distribution centers on Earth. The Marshall center is conducting studies, both in-house and under contract, aimed at defining overall systems requirements, identifying new technology necessary for development, and detailing problems to be solved in transporting, erecting and maintaining the system in space.

It appears that a new group of transportation vehicles will be needed for transporting, erecting and maintaining the Satellite Power Systems and other large space structures. Vehicles included in the new group are the heavy lift launch vehicles, orbital transfer vehicles and the growth shuttle. Several studies are underway presently at MSFC that may result in development of such additions to the STS.

One MSFC program with a direct impact on society as a whole is the conversion of sunlight into thermal energy for heating and cooling. MSFC is managing development of solar heating and cooling systems for the Energy Research and Development Administration's



Studies of a heavy lift launch vehicle currently are underway at the Marshall center, in research centered on the development of a useful addition to the Space Transportation System. In this artist's concept, a vehicle is shown that would be capable of carrying payloads of 72 metric tons into space, thus offering greatly increased economy and payload flexibility over the basic Space Shuttle for the heavy and bulky payloads anticipated with the advent of the space industrialization and large structures era.

nationwide demonstration programs as well as providing technical management support and collecting pertinent data for commercial and Government demonstration sites in 22 states and the Virgin Islands.

Another project has to do with developing methods for increasing the productivity and efficiency of coal-mining equipment.

Technology involving material processing based on space-developed techniques is high on the list of NASA's commitments. A five-year series of Space Processing Applications Rocket launches began last December at MSFC, dedicated to probing methods of processing materials in a gravity-free environment. SPAR's goal is to expand upon the experimental observations made during manned missions and provide a low-cost means of obtaining data on space processing in near-weightlessness. These data will be highly significant to projects to be carried out aboard the Space Shuttle.

Most of MSFC's 4,100 civil servants are assigned to the Huntsville center, with small groups working at the Slidell Computer Complex in Slidell, La., and in the Michoud Assembly Facility in New Orleans. Both units are part of the Marshall center. Other MSFC employees are assigned to installations and contractor facilities throughout the U.S., in Florida, Tennessee, Mississippi, Louisiana, Missouri, Colorado, California and Massachusetts. Two employees are stationed in the Netherlands as Spacelab program representatives.

Dr. William R. Lucas became director of the Marshall center in 1974, succeeding Dr. Rocco A. Petrone. Lucas, a metallurgist, has been with the center and predecessor organizations for 23 years in scientific and program management positions.

The center is situated in the Tennessee Valley on 1,800 acres near Huntsville. Facilities include the headquarters complex with executive offices in a nine-story building. Two six-story buildings house program, administrative and technical offices. Several large laboratories, shops and test stands are nearby. Certain facilities, such as the Redstone Arsenal air strip, and some utilities are shared by the center and the Army.

The center has deepwater access via the Tennessee, Ohio and Mississippi Rivers.

The Michoud Assembly Facility in New Orleans, originally the assembly site for the first stages of Saturn launch vehicles, is now used in the fabrication of Space Shuttle external tanks. The manufacturing building, one of the largest single-floor edifices in the country, covers 43 acres. A barge dock at Port Michoud opens into the intracoastal waterway, permitting barge shipment of the huge assemblies produced at the facility.

The Slidell Computer Complex, 20 miles northeast of Michoud, occupies 14 acres and provides a centralized computer service for Michoud, the National Space Technology Laboratories (Miss.) and associated contractors.

Marshall's Director Lucas had this to say about the outlook for the center:

"We are in a new era of space exploration today. In looking back to the Saturn/Apollo, Skylab and ASTP programs—in the satisfaction and pride in having contributed to their successes—it is natural that we also feel some tinge of regret at the closing of an era.

"That regret, however, is quickly dispelled with the thought that the past has value only in that it shapes today and tomorrow.

"The Marshall center today consists of a team of people with demonstrated vision, determination and dedication—qualities that characterize the very best in human nature. Our people are our strongest asset and our hope for the future. Our employees, possessing uncommon ability, have evolved into a team that has attained unusual levels of competence. And it is a close-knit team, bound together by mutual respect and friendship.

"In the new era of the space program, in which low cost and applications are as important as initial exploration, the Marshall center has become a multi-project scientific and engineering center, making full use of those individual and team capabilities so carefully developed during our formative years.

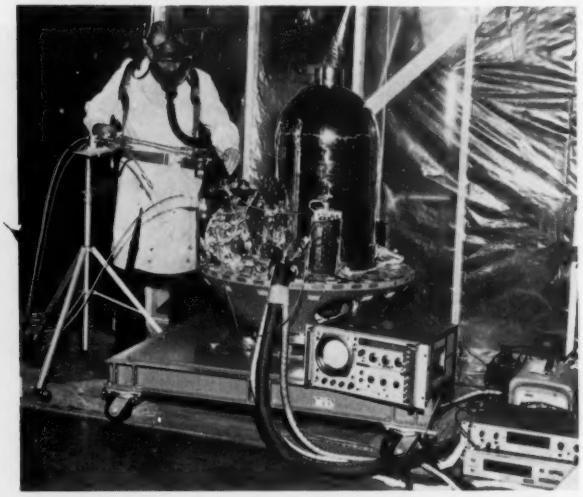
"We have maintained our expertise in rocket propulsion, large launch vehicles, structural design, flight systems dynamics, and systems engineering and integration. At the same time we have developed centers of excel-

MSFC director Dr. William R. Lucas (seated) scrutinizes a half-scale model of the satellite named Lageos (for Laser Geodynamic Satellite), being shown by Charles W. Johnson, manager of the Lageos task team. Lucas became MSFC director in 1974.

lence in several areas of space science and applications in preparation for the new roles of the late 1970s and 1980s.

"For the future, we anticipate a Space Telescope program, the Shuttle Interim Upper Stage and Tug, Zero-G Cloud Physics, Multi-Mission Support Equipment and payload specialist station activities. We also are planning for a Space Station, Solar Power Satellite, heavy lift launch vehicles, advanced propulsion and other projects of the future.

"We intend to continue, despite the austerity of resources, our dedication to excellence in this diversity of important assignments."



Make-readiness for Rocket to Test Einstein Theory—Marshall technician L. H. Oldfield tests the experimental payload for the Gravitational Redshift Space Probe, the satellite to be launched from the Wallops Flight Center in June or July. The objective of the experiment is to test basic principles of the Einstein Theory. The small payload was developed at MSFC.

Meeting on Space Topics

A two-day symposium on "Space Industrialization" was held at the Marshall Space Flight Center May 26 and 27. Sponsored jointly by the Alabama Section of the American Institute of Aeronautics and Astronautics and the Marshall center, the symposium covered four primary topics: Space Habitation, Space Transportation, Space Processing and Space Power.

Participation included NASA centers and organizations, other government agencies, industry and universities. James A. Downey III, deputy director of MSFC's Program Development directorate, chaired the event.

R. T. Jones Is Awarded $15,000

Jones

The scientist who devised the swept wing seen today on most aircraft and the revolutionary oblique wing which slants in its entirety across the fuselage, received a $15,000 award recently at the Ames Research Center.

Dr. Robert T. Jones, senior staff scientist at Ames, received the award, one of the largest ever made, for his many contributions to aeronautics. He is an international authority on aerodynamics, optics and biomechanics—all this without a college degree. Much of his education was derived from on-the-job training and, in 1931-34, from night classes under Dr. Max Munk, who was a NACA scientist and a pioneer aeronautics researcher.

Jones is the author of 64 technical papers, including one on the swept wing, an innovation that made possible transonic and supersonic flight. Others deal with lift, drag, fluid flow, telescopes, times for interplanetary trips, relativity, designs for an artificial heart and a violin.

Jones received an honorary Doctor of Science degree from the University of Colorado in 1971, was made a member of the National Academy of Engineering in 1973, and in 1946 received the Sylvanus Albert Reed Award of the American Institute of Aeronautics for his swept wing work.

New Legal Appointment

Gerald J. Mossinghoff recently was named Deputy General Counsel for NASA. He has been NASA's Assistant General Counsel for General Law since January 1974.

Mossinghoff

Mossinghoff joined the agency in 1963 as a patent attorney in the Office of General Counsel. In 1966 he was appointed director of the Office of Legislative Planning, U.S. Patent Office. He returned to NASA in December 1967, to become director of Legislative Liaison in Legislative affairs.

Mossinghoff received NASA's Exceptional Service Medal in 1971. Educated at St. Louis University and George Washington University, he is a member of the Missouri and D.C. bars, the American Bar Association and the Federal Bar Association, and is a registered patent attorney.

Did You Know?

NASA recently released a new 28-page catalogue of free-loan motion pictures. A total of 89 general interest and educational films are listed, including synopses and instructions for ordering the films through eight NASA regional film laboratories. For a free copy of the list, write Office of Public Affairs, Code FGM, NASA Headquarters, Washington, D.C. 20546.

The National Fire Protection Association's International 1975 Fire Prevention Contest gave special recognition to the Marshall Space Flight Center "for noteworthy prevention activities in the interests of life, safety and protection of property." No fires occurred at MSFC during 1975, a fact which officials say is largely because of employee cooperation and participation in the center's fire prevention training program. A Certificate of Merit was presented to the center by the NFPA. The organization has been the clearinghouse of information on fire prevention and firefighting procedures for 80 years.

Two finalists in this year's Annual Science Talent Search carried out research and otherwise prepared their scientific projects at two of NASA's field installations. Diane H. Wooden, 17, of Rockville, Md., who won a $6,000 scholarship for her study of galactic dust, used a 36-inch reflecting telescope at the Goddard Space Flight Center to take photographs of a dark cloud which is a concentration of dust grains in the galaxy. The dust clouds absorb light from background stars. The denser the cloud the more light it absorbs. The higher density regions are thought to be the beginnings of early star formation. The student devised a method different from the one conventionally used to count stars on the photographic plate and thus was able to detect much of the higher density regions that otherwise might have been missed.

James E. Black, 17, of Fremont, Calif., worked at the Ames Research Center on the development of methods by which pure chlorine dioxide might be produced and stored. Chlorine monoxide, which is produced from chlorine dioxide, is a chemical required by scientists for study because of its suspected part in the ozone-destroying reaction believed to be caused by Freon propellants.

The annual Science Talent Search has been sponsored for 35 years by the Westinghouse Electric Corp., and Science Service. The competition offers an all-expense paid, five-day stay in Washington, D.C. to high-school seniors selected as finalists. In 1975, the students shared $65,500 in scholarships and awards.

The largest American flag ever painted, along with a mammoth American Bicentennial symbol, decorate the south outside wall of the Kennedy Space Center's Vehicle Assembly Building for the duration of the May-September Bicentennial Exposition on Science and Technology. More than 500 gallons of paint were used for the 64- by 33-meter (209 by 110 feet) flag and the 33- by 33-m. (110 by 110 ft.) symbol. The work was done by Apollo Painting Inc., of Merritt Island, Fla.

Harrison Schmitt, former NASA scientist-astronaut crew member on Apollo 17 and former director of NASA's Energy R&D Program until 1975, is seeking the Republican nomination for Senator in New Mexico.

An extension of a contract for reproduction services recently was awarded to McGregor & Werner, Inc. of Washington, D.C., by NASA's Kennedy Space Center. The extension is for two months, and is worth $246,696. A set-aside for small business concerns, the contract is for printing, reproduction and microfilming/documentation services.

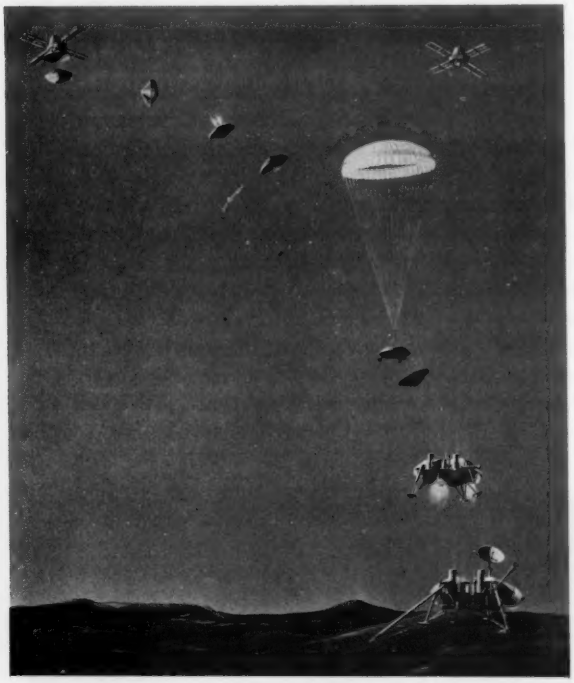
Tom C. Bannister, a physicist in the Space Sciences Laboratory at the Marshall Space Flight Center, was awarded an Alfred P. Sloan fellowship by the Massachusetts Institute of Technology for the 1976-77 academic year.

A spokesman for TWA Services, Inc., a wholly owned subsidiary of Canteen Corp. of America, KSC's concessionaire for operation of the Visitors Information Center, NASA Tours and the Bicentennial Exposition, said that company expenditures in 1975 totaled almost $5 million. Salaries were $1.6 million and purchases of food, souvenirs and other items amounted to $3.3 million. The company awarded contracts worth $2.2 million, of which $1.4 million went to Brevard County (Fla.) firms. The new carousel cafeteria at KSC, operated by TWA Services, is able to feed up to 1,300 persons an hour. ■ ■ ■ ■

Assessing Martian Atmospheric Conditions

Next month, after an 11-month journey through 736 million kilometers (460 million miles) of space, NASA's Viking Lander will have just five minutes to profile and analyze the Martian lower atmosphere.

A research project aboard the Lander called the Lower Atmosphere Structure Experiment was developed at NASA's Ames Research Center to produce a profile of the temperature, pressure and density of 100 km (60 mi.) of the atmosphere abutting the Martian landing site. At that stage of the spaceflight, the Lander will decelerate rapidly, moderating from about 4,500 meters per second (10,000 miles per hour) to three m/s or six mph. Touchdown is scheduled for 9:41 p.m. EDT on July 4.



Martian Life-Detecting System—An artist's concept of the sequence of events that will take place just before a life-detection laboratory arrives on the surface of Mars July 4. At top right, the Viking spacecraft, composed of an Orbiter and a Lander, in orbit around the Red Planet, taking pictures of the planned landing site to ascertain how hospitable it will be for the Lander (top left) during a three- to five-hour descent. Protected by aeroshells, the heat-sterilized Lander hurtles into the thin Martian atmosphere, to be slowed first by aerodynamic drag until the shell is discarded, then by parachute (center) and finally by retrorockets to assure a gentle landing. Instruments will study the structure and composition of the Martian atmosphere as the Lander drifts downward. During the final six kilometers (20,000 feet) of descent, another set of temperature and pressure sensors come into play, one on the Lander's foot pads, another inside the Lander through a tube extending out from the vehicle. Viking 2 is scheduled to arrive at Mars on Aug. 7 and touch down on the surface Sept. 4.

The experiment is one of three investigations developed by members of the Viking Entry Science Team. The other two will analyze the composition of the gases of the upper atmosphere and measure ion and electron energy during the Martian entry to determine ion type and concentration.

Alvin Seiff, chief investigator of the lower atmosphere experiment at the Ames Space Science Division, expects the study to solve some of the puzzles about Martian winds and atmospheric temperature and pressure. He points out that 90 m/s (200 mph) winds apparently cause periodic planet-wide dust storms on Mars, but that present theory—based on numerical models rather than direct measurements—does not support the occurrence of winds of that intensity. Measurements of horizontal wind velocity and atmospheric temperature at different altitudes will help explain the wind dynamics of the Martian atmosphere. Seiff also believes that the investigation can help scientists to a better understanding of the circulation of Earth's atmosphere, which controls our weather patterns.

An accelerometer on the Lander will measure the craft's rate of deceleration as the vehicle descends through the Martian atmosphere. Accelerometer readings also will provide density, pressure and temperature profiles during the five-minute period.

Ensuing pressure studies will help determine what gases besides carbon dioxide the Martian atmosphere holds. The presence of argon is now considered likely. If even a trace of nitrogen is found on Mars, the odds in favor of the existence of some form of life on the planet will increase considerably.

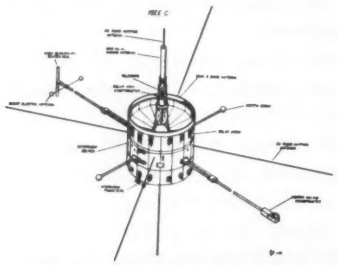
No attempt will be made to retrieve the Lander after it arrives on the Martian surface.

Long-distance Look at Eastern Shore—A photograph of the Eastern Shore and Chesapeake Bay was presented recently to Judge N. Wescott Jacob (left) in the Accomack County Courthouse (Va.) by Wallops Flight Center director Robert L. Krieger. The six-photo montage is a color infrared composite photograph from Landsat, the earth resources technology satellite, taken from an altitude of 562 statute miles on two successive days.

Contractor Selected for New Spacecraft

Fairchild Space and Electronics Company of Germantown, Md., has been selected by NASA for negotiation of a contract for the integration and testing of the International Sun Earth Explorer-C spacecraft. Estimated cost of the cost-plus-award-fee contract is $4 million, exclusive of base and fee award. Its duration is spacecraft launch plus six months.

The ISEE-C spacecraft will be drum-shaped, will weigh about 453 kilograms (1,000 pounds), and measure 1.73 meters (68 inches) in diameter and 1.61 m (63 in.) in height. It will be launched on a Delta rocket in 1978 from the Eastern Test Range into heliocentric orbit. The spacecraft will carry 12 scientific experiments involving measurements of isotropic concentration of solar and galactic cosmic rays, and investigation of various solar, interplanetary and recently discovered astrophysical and magnetic features.



The International Sun Earth Explorer Spacecraft—A preliminary drawing of the ISEE-C satellite, to be manufactured by the Fairchild Company for launch within two years.

The contract will be managed by the Goddard Space Flight Center, which will supply all experiments, major instrumentation and black boxes, the hydrazine propulsion subsystem and other items. Among other things, the contractor will provide designs of systems to be used, modify and develop software as required, assemble and test the spacecraft, and provide launch and post-launch support and documentation.

Senior NASA Official Dies

Dr. Oscar E. Anderson of NASA's International Affairs Office since 1962, died recently after a heart attack. As director of the International Program Policy Division at NASA, Dr. Anderson had a key role in developing space cooperation with the Soviet Union, which culminated in the Apollo Soyuz mission last year. For his contributions to U.S.-Soviet space cooperation, he received NASA's superior performance award in 1967 and the Exceptional Service Medal in 1973.

Dr. Anderson was born in South Bend, Ind., in 1918. He graduated with honors from Oberlin College in 1940 and completed his master's degree in history at Harvard University before entering the U.S. Army Air Force in 1941. He served as an intelligence officer with the Sixth Bomber Command in the Panama Canal Zone and wrote a history of the command. He was discharged with the rank of captain in 1946.

Anderson

After receiving his Ph.D. in history at Harvard, Dr. Anderson for ten years was assistant and associate professor of history at the University of Cincinnati. He was one of the first American historians to attempt to describe the role of science and technology in American life. In the 1950's, he produced two books on that theme: *Refrigeration in America;* and *The Health of a Nation: Harvey W. Wiley and the Fight for Pure Food.*

Dr. Anderson came to Washington in 1958 as a member of the historical staff of the U.S. Atomic Energy Commission, where he helped to establish the historical program for that agency. He was coauthor of the first volume of the AEC official history, for which he received an outstanding service award.

At the time Dr. Anderson joined NASA, he was asked why he had decided to abandon his distinguished career as a historian. His response was that after writing history, he wanted to help make it.

Dr. Anderson was a member of Phi Beta Kappa, the American Historical Association, and the Organization of American Historians.

Typing Champ—Jean Lipscomb, a high-school student who works parttime at the Marshall Space Flight Center, recently won first prize in a typing contest sponsored by the Future Business Leaders of America Club. Competitors were from 25 schools in northern Alabama. Lipscomb works four hours a day as a clerk-typist at the center under the Business Opportunity Education Program at Johnson High School.

Technology Publication

The first issue of a new two-color journal, NASA *Tech Briefs* appeared in April, replacing the well-known, one-page *Tech Briefs* which began publication in 1963. *Tech Briefs* is published by NASA's Technology Utilization Office for the benefit of non-aerospace users of NASA technology.

The new quarterly journal contains the same kind of information previously published in the single pages, as well as material concerning innovations, formerly carried in Technology Compilation booklets.

Project officials expect that the new journal annually will publish data on more than 600 innovations, concepts, publications and computer programs. Each issue also will carry a section entitled "New Product Ideas," that focuses attention on new developments with a potential for commercial usage. Other sections list books, reports and computer programs available to domestic users, and carry a comprehensive subject index.

Describing the new journal, Louis Mogavero, director of the Office of Technology Utilization, said: "We are convinced that the changes will go a long way in fulfilling our goal of assuring the American taxpayer the maximum return on his investment in space research in the form of new, better and more economical products and processes."

U.S. citizens wishing a free subscription to *Tech Briefs* should write: Director, Technology Utilization Office, P.O. Box 8756, Baltimore Washington International Airport, Md. 20240.

Spacelab Contract Awarded

The first contract for the modification of Kennedy Space Center facilities to process the European-built Spacelab has been awarded to Pan American Technical Services, Inc., Cocoa Beach, Fla.

The $129,627 contract covers architect/engineer services for the design of modifications to the Operations and Checkout Building, to convert it for Spacelab processing as part of the Space Shuttle program.

Spacelab, to be carried in the Space Shuttle Orbiter, will have two elements—a pressurized manned laboratory module so scientists and engineers can work in a normal shirt-sleeve environment; and an instrument platform to support telescopes, antennas and other equipment requiring direct space exposure.

The Spacelab engineering model to be used for facilities and Orbiter checkout is scheduled to arrive at KSC in July 1978. The first flight model should be received in June 1979. The first Spacelab mission is to be flown in 1980.

Operations and Checkout Building modifications include changes in utilities (gaseous nitrogen, helium, high pressure air, water, air-conditioning) and adaptation of the Apollo Acceptance Checkout Equipment rooms to make them compatible with ESA-furnished ground support equipment for Spacelab testing. The building, in the KSC Industrial Area, was used for the assembly and checkout of Apollo and Skylab spacecraft.

Big Savings Receive Presidential Recognition—R. Dean Bratton (right) and S. Harry Berlocher hold framed letters from President Ford, recently presented to them by Johnson Space Center Director Dr. Christopher C. Kraft, Jr. The letters were in recognition of employee suggestions that resulted in a first year saving of $218,500. Bratton (Earth Observations Division) foresaw a need for developing a technique to provide for microfilm duplication of color imagery. His work with Eastman Kodak in the processing of earth resources aircraft photography brought about a documented saving of $196,000 in 1974. Harry Berlocher (Engineering Division) suggested that condensate water from cooling coils in the air conditioning system be reused as boiler and cooling tower makeup water. That suggestion resulted in documented yearly savings of $22,500.

New Chief for Goddard Center

Dr. Robert S. Cooper, currently deputy director of the Goddard Space Flight Center is to become director of that center July 1. He replaces Dr. John F. Clark, retiring after 10 years as Goddard's director.

In his present job at the center, Cooper serves as general manager for GSFC's wide range of space science, applications and tracking programs. Before he came to Goddard in 1975, he served for three years as assistant director for Research and Engineering, Space and Advanced Systems, in the Office of the Secretary of Defense.

As director of Pentagon space research activities, Cooper managed the new precision navigation satellite system called NAVSTAR Global Positioning System, now slated for full-scale testing late this year. He also was the Secretary of Defense's principal technical advisor on Space Shuttle and other NASA-related work. He received the Secretary of Defense Meritorious Civilian Service Award for his activities at the DOD.

Cooper was awarded his B.S. degree in electrical engineering at the University of Iowa, an M.S. degree from Ohio State, and a Sc.D. degree from MIT, where he continued as a Ford Foundation post-doctoral fellow for two years. He worked for MIT in various capacities during the 1960s.

Cooper is a member of the American Association for the Advancement of Science and the American Phyical Society.

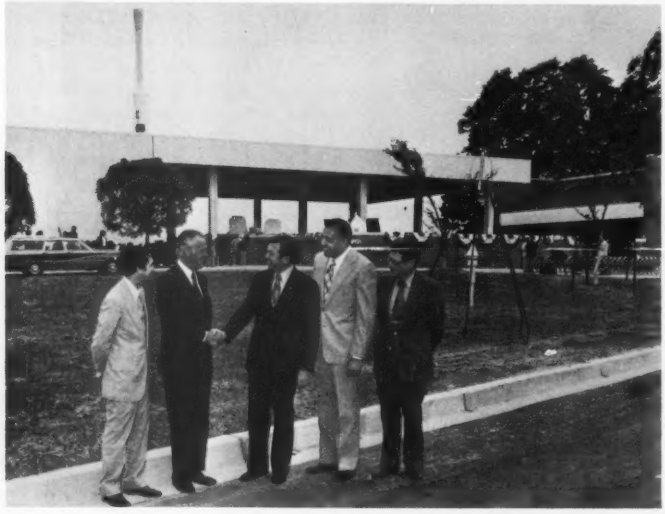
The departing director, Clark, is an authority on atmospheric and space sciences and applications. During his tenure, the Goddard center has seen major advances in communications, weather and climate, Earth resources, space physics and space astronomy.

Clark came to NASA in 1958. From 1963 to 1965, he served as deputy associate administrator for Space Sciences and Applications. From 1962 to 1965 he also served as chairman of the Space Science Steering Committee.

His professional awards include the 1974 Collier Trophy for leadership in development of the Landsat program (co-recipent) and the NASA medals for Distinguished Service, Outstanding Leadership, and Exceptional Service. He is a fellow of the American Institute of Aeronautics and Astronautics, the American Astronautical Society, and the Institute of Electrical and Electronics Engineers.

Procurement Chief Leaves NASA

Rear Admiral Kenneth L. Woodfin, USN (ret.) resigned as Assistant Administrator for Procurement effective May 31 to accept a position with the firm of Burns and Roe, Inc., at Oradell, N.J. Woodfin has been with NASA for the past year. Previously he held numerous positions in the Navy, the last being Deputy Chief of Naval Material (Procurement and Production).



Space Program on Display at Goddard—The new visitors center at NASA's Goddard Space Flight Center, Greenbelt, Md., opened to the public in mid-May. Present at opening day ceremonies were (left to right): William A. Mecca, Jr., Director of Administration and Management at GSFC; Elmer S. Groo, NASA Associate Administrator for Center Operations; Dr. John F. Clark, director of GSFC; Dr. Robert S. Cooper, deputy director; and Dr. Glen P. Wilson, staff member of the Senate Committee on Aeronautical and Space Sciences, representing Senator Frank E. Moss, committee chairman. The center is open daily except Sunday and Monday from 10 a.m. to 3 p.m. Numerous exhibits and demonstrations of space techniques, artifacts, satellite operations and spin-off benefits from the space program can be seen in self-guided tours of the facility.

News about the Bicentennial Exposition at the Kennedy Space Center

NASA's KSC is the site, from May 30 to Labor Day, for the Bicentennial Exposition on Science and Technology, the only exposition sponsored by the U.S. Government during the Bicentennial Year.

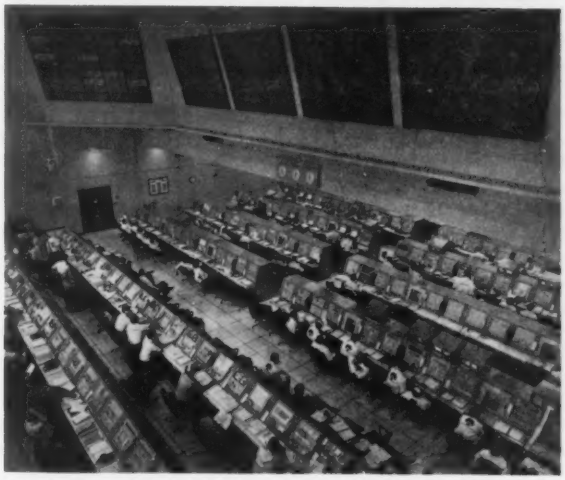
Exhibits by 16 Government agencies and many industrial firms provide a glimpse into the future—a look at the many ways in which today's achievements will make life in the United States better and more comfortable during the nation's next 100 years.

Medicine, housing, energy production, undersea exploration and a mammoth laser light sculpture are only some of the exhibits available to visitors. Exhibits are housed in 15 large pavilion domes and in the Vehicle Assembly Building.

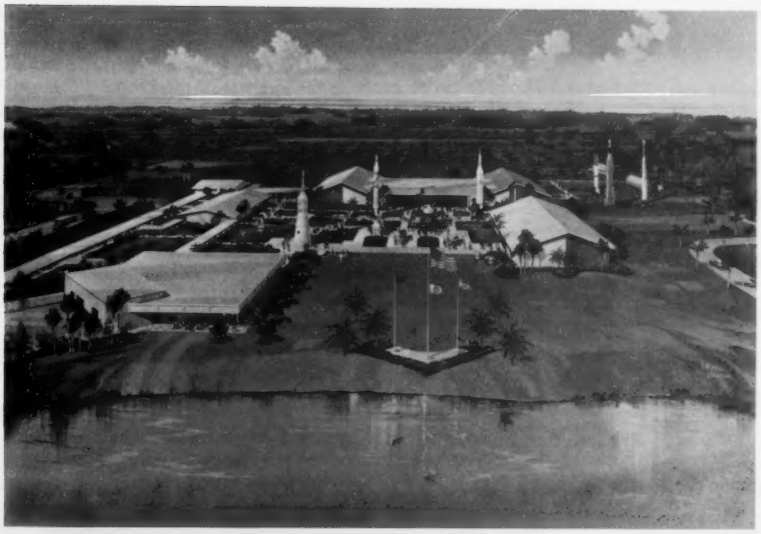
The list of exhibitors includes: HEW, Treasury, ERDA, the American Revolution Bicentennial Administration, EPA, National Endowment for the Arts, the DOD, HUD, Interior, NSF, Community Services Administration, Agriculture, Commerce, U.S. Postal Service, DOT, McDonnell Douglas, TRW, Rockwell, United Technologies Corp., General Dynamics and Lockheed.

The KSC visitors information center, one of the Southeast's major tourist attractions, is open daily during the exposition. Hours for the exposition are 10 a.m. to 7 p.m.; for the visitors center, 8 a.m. to about sunset. (The last bus tour leaves the center 2½ hours before sunset and the center stays open usually until an hour after the last bus riders have returned.)

Admission fees are: for combined tour of exposition and space center $5.00 for adults; $2.75 ages 13 through 18; $1.25 ages 3 through 12. Exposition only, $3.00 for adults; $2.00 ages 13 through 18; $1.00 ages 3 through 12. Space center tour only, $2.50 adults; $1.25 ages 13 through 18; fifty cents ages 3 through 12. Tickets may be purchased at the exposition entrance or the visitors information center.



Apollo Era Revisited—Visitors to the Bicentennial Exposition on Science and Technology at the Kennedy Space Center this summer will be able to relive the sights and sounds of an Apollo launch at Firing Room 3 in KSC's Launch Control Center. A multi-media re-creation of the launch of Apollo 11 on man's first journey to the lunar surface will use the room's four large screens, operational sequence boards and other effects to simulate the countdown and launch of an Apollo Saturn 5. This picture shows how it was during such an event.



Improved Visitor Facilities at KSC—Additions have been made to the Kennedy Space Center Visitors Information Center this year to make tours more pleasant for the more than a million visitors expected at the Bicentennial Exposition on Space and Technology. Seen in this photo are (foreground at left) a new fast food service building; (center) new cluster of flags with the Stars and Stripes and the America Revolution Bicentennial Administration flag flanked by the official flags of NASA and Florida. A new Hall of History at right is under construction. One thousand parking spaces have been added, bringing the total to 3,000.

Lunar Sample Exhibits

The following is a schedule of lunar sample exhibits from mid-May to mid-June:

Alabama—Bicentennial Armed Forces Day Open House, Anniston, May 15.
California—Gemstone Festival, Sacramento, May 15-16.
Ohio—Bicentennial Celebration and Open House, Newark Air Force Station, Newark, May 16; Bicentennial Celebration, Youngstown State University, Youngstown, May 16; Armstrong Air & Space Museum, Wapakoneta, April 1-Sept. 1.
South Carolina—Florence Museum, Florence, May 17-30.
Texas—Scout-O-Rama, Texarkana, April 27-May 18; Palo Pinto Historical Assn., Inc., Bicentennial Celebration, June 12-19.
West Virginia—South Charleston Jr. High School, South Charleston, May 27.
American Freedom Train—Nashville, Tenn., May 20; Louisville, Ky., May 25; Charleston, W. Va., June 3; Pittsburg, Pa., June 9.
High Flight Foundation Bicentennial Mobile Space Museum—Tulsa, Okla., May 10-16; Salina, Kan., May 18-23; Colorado Springs, Colo., May 25-June 6; Farmington June 8-13 and Lovington, N.M., June 15-20.
Tennessee Valley Association-Bicentennial Caravan—(Ky.) Richmond, May 15; Lexington, May 16-18; Frankfort, May 19-20; Covington, May 21-22; Louisville, May 23-27; Elizabethtown, May 28; Owensboro, May 29-30; Henderson, May 31-June 1; Madisonville, June 2; Paducah, June 3-4; Land Between the Lakes, June 5-7; Hopkinsville, June 8; Bowling Green, June 9-10; Somerset, June 11; Middlesboro, June 12; Knoxville, June 13-17.

Long-term Displays

Alabama—Ala. Space and Rocket Center, Marshall Space Flight Center, Huntsville.
Florida—Visitor Information Center, Kennedy Space Center.
Kansas—Eisenhower Library, 200 SE 4th St., Abilene.
Mississippi—The National Space Technology Laboratories, Bay St. Louis.
New York—United Nations Building, New York City.
Ohio—USAF Museum, Wright Patterson AFB.
Virginia—Visitor Information Center, Langley Research Center, Hampton.
Washington, D.C.—National Geographic Museum; Smithsonian Institution, National Air and Space Museum, 100 Jefferson Drive; Washington National Cathedral.

Radio-Television . . . . . .

(Released Nationally)
TELEVISION: A 4½-minute and a 90-second film have been released in the Aeronautics and Space Report monthly series, entitled "Vikings Speed Toward Mars."
RADIO: Five weekly Space Story programs have been released—"Viking Radio Science" (LaRC/Tolson); "Shuttle Approach and Landing Tests" (JSC/Slayton); "Viking-Mars Organic Analysis" (U. of Texas, Dr. Oro); "Meals Systems for the Elderly" (JSC/Primeaux). One monthly NASA *Special Report* has been released: "Viking . . . Mars . . . and Planetary Atmospheres" (Harvard University, Dr. Michael McElroy). One set of ten 60-seconds NASA *Space Notes* announcements, all on Viking, has also been released

Projected Launch Schedule

(*As of May 1976*)

Name	Launch Date	Vehicle	Range	Mission Remarks
Relativity	June 18 (earliest)	Scout	WI	Scientific probe to make a test of the Einstein Theory.
Navy Transit	June 23	Scout	WTR	Navy Navigation satellite. Reimbursable.
Indonesia-A (Palapa)	July 8	Delta	ETR	Indonesian communications satellite. Reimbursable.
Comstar-B	July 22 (earliest)	Atlas/Centaur	ETR	Second domestic communications satellite for Comsat. Reimbursable.
NATO IIIB	August	Delta	ETR	Communications satellite in synchronous orbit to perform communications relay for NATO. Reimbursable.
ITOS-E2	September	Delta	ETR	Operational meteorological satellite of the National Weather Service to provide day and night cloud-cover imagery. Reimbursable.
RCA-C	October	Delta	ETR	Third domestic communications satellite for RCA. Reimbursable.
Marisat-C	December	Delta	ETR	Third Comsat satellite to provide maritime satellite communications service. Reimbursable.
Intelsat-IVA-C	December	Atlas/Centaur	ETR	Third of a series of improved Intelsat satellites. Reimbursable.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel for the indicated installation.

Inventor(s) and Employer(s)	Title and NASA Docket	Patent No.	Installation
John F. Sutton, NASA/GSFC	Synchronized Frequency Transposer	3,949,174	GSFC
Grant W. Coon, NASA/ARC	Trielectrode Capacitive Perssure Transducer	3,948,102	ARC
Lester J. Owens, NASA/KSC	Apparatus for Connecting a Prosthesis to a Bond	3,947,897	KSC
Bruce A. Banks, NASA/LeRC	Method of Constructing Dished Ion Thruster Grids to Provide Hole Array Spacing Compensation	3,947,933	LeRC
Paul W. Shores, NASA/JSC	Position Determination Systems	3,949,400	JSC
Kenneth A. Green, Microwave Research Corp., N. Andover, Mass.	Highly Efficient Antenna System Using a Corrugated Horn and Scanning Hyperbolic Reflector	3,949,404	NaPO
Harold Perkins, NASA/MSFC	System for Imposing Directional Stability on a Rocket-Propelled Vehicle	3,948,470	MSFC
Thomas R. Edwards, NASA/MSFC Hugh W. Zeanah, NASA/MSFC	Filtering Device	3,949,206	MSFC
George C. Gilley, Caltech/JPL	Shared Memory for a Fault-Tolerant Computer	3,950,729	NaPO
William J. Abernathy, NASA/MSFC Lowell G. Snoddy, NASA/MSFC	A Hanger	3,951,366	MSFC
Lott W. Brantley, Jr., NASA/MSFC	Solar Energy Absorber	3,951,129	MSFC
Howard E. Goldstein, NASA/ARC Marnell Smith, NASA/ARC Caniel Leiser, NASA/ARC	Silica Reusable Surface Insulation	3,952,083	ARC
Harold E. Sliney, NASA/LeRC	Bearing Material	3,953,343	LeRC
Lawrence P. Ludwig, NASA/LeRC	Fluid Seal for Rotating Shafts	3,953,038	LeRC
Carroll T. Pardoe, Applied Physics Lab., the Johns Hopkins University, Silver Spring, Md.	Telemetry Synchronizer	3,953,674	GSFC
John Dimeff, NASA/ARC	Nulling Device for Detection of Trace Gases by NDIR Absorption	3,953,734	ARC
Richard T. Whitcomb, NASA/LaRC	Airfoil Shape for Flight at Subsonic Speeds	3,952,971	LaRC
Thomas R. George, Jr., Rockwell Intl. Corp., Rocketdye Div., Canoga Pk., Calif.	A Device for Installing Rocket Engines	3,952,998	MSFC
Alexander Pechman Robert M. Beasley	Lockheed Missiles & Space Co., Inc. Sunnyvale, Calif. — Ceramic Coating for Silica Insulation	3,953,646	JSC
Newton D. Brown Gordon L. Jeppesen Nicholas C. Costakos	Goodyear Aerospace Corp., Arkron, Ohio — Deployable Flexible Tunnel	3,952,976	MSFC
George L. Von Pragenau Irving T. Morgan Clifton A. Kirby	NASA/MSFC — Translatory Shock Absorber for Attitude Sensors	3,952,980	MSFC
Jimmie J. Wortman Robert P. Donovan Arthur D. Brooks Larry K. Monteith	Research Triangle Institute, Research Triangle Park, N.C. — Particulate and Aerosol Detector	3,953,792	LaRC
William H. Kinard, NASA/LaRC Robert L. O'Neal, NASA/LaRC			

Visitors from NASA Headquarters—Recent visitors to the Dryden Flight Research Center were Dr. Harriet Jenkins (right), Assistant Administrator for the Office of Equal Opportunity Programs; and Deputy Assistant Administrator for EO programs, Peter Chen. The two toured the center and met with Dryden employees, including EO officer Jo Marie Di Maggio.

NASA Tech Briefs

The Technology Utilization Office, NASA Headquarters

The following awards for innovations of importance to projects at the indicated NASA centers were recently given. The affiliation of non-NASA recipients appears in parentheses. Additional details concerning the awards are published in the spring issue of NASA Tech Briefs. (See page 21 for information about the new journal.)

Ames Research Center

Robert W. MacCormack
Salvatore R. Riccitiello

Goddard Space Flight Center

Emmett W. Chappelle & Grace Lee Picciolo
Samuel R. Floyd & Edward F. Thomas, Jr.
Hiram Lopez
(Northrop Services Inc.)
Andrew J. Parker
(Hittman Associates)
Daniel P. Peletier
(John Hopkins University)
Joseph M. Sherfey
William C. Stange
Edward F. Thomas
Edward F. Thomas & Samuel R. Floyd
J. A. Troendle
(Lockheed Missiles & Space Co.)
Lawrence D. Wing

Headquarters

J. R. Galvaler & M. A. Janocko
(Westinghouse Electric Corp.)
Warren C. Kocmond & Vito A. DePalma
(Cornell Aeronautical Lab. Inc.)
Louis N. Mogavero
Net. S. Rasor & Edward J. Britt
(Atomic Energy Commission)
Stanley A. Reible
(University of Wisconsin)

Johnson Space Center

Charles S. Beuyukian & Mike J. Mitchell
(Rockwell Intl. Corp.)
E. H. Cirlin, R. M. Housely & B. R. Tittmann
(Rockwell Intl. Corp.)
J. L. Day
Thomas W. Doak, Richard B. Merwin, Samuel E. Zuckswert & Werner Sepper
(Philco-Ford Corp.)
Christopher Grant
(Martin Marietta Corp.)
Robert J. Guyan
(Rockwell Intl. Corp.)
Fred A. Houte, Morris B. McKee & Thomas C. Patten
(McDonnell Douglas Corp.)
Richard L. Johnson
(The Garrett Corp.)
Lockheed Electronics Co. (2 awards)
Sheldon L. Lieberman (2 awards)
(Furane Plastics, Inc.)
Michael A. Mezzacappa
(Rockwell Intl. Corp.)
Rex A. Moses
(Rockwell Intl. Corp.)
Thomas Nies
(Honeywell, Inc.)
Walter M. Surrency & Paul S. Moravek
Robert Weagant & Nancy Aldrich
(Honeywell, Inc.)

Kennedy Space Center

H. W. Beimgraben
(The Boeing Co.)
E. W. Fickey & D. M. Smoot
(Bendix Corp.)
Charles R. Gilley & John R. Schanbacher
(The Boeing Co.)

Langley Research Center

Robert M. Baucom & Terry L. St. Clair
Bill T. Baugh
Vernon L. Bell
Philip N. Bolinger & Harry W. Rauch
(General Electric Co.)
Robert A. Champine
Chris Gross
D. W. Halstead, L. L. Tripp, M. Tamekuni, L. L. Baker & A. V. Viswanathan
(The Boeing Co.)
Rodney D. Henry
(Rockwell Intl. Corp.)
Moses J. Long & Stephen C. Irick
Mike D. Mason
(Martin Marietta Corp.)
Waldo I. Oehman
Craig W. Ohlhorst
Lawrence E. Putnam
Edward W. Schwartz
(General Dynamics Corp.)
Charles M. Ward
(Martin Marietta Corp.)
John W. Wilson

Lewis Research Center

Bernhard H. Anderson
Arthur G. Birchenough
Peter T. Bizon & David A. Spera
Peter T. Bizon, William J. Waters & David A. Spera
George Foerster, Oral Mehmed & Richard Mueller
Lucille C. Geyser & F. K. Bruce Lehtinen
Marvin H. Hirschberg
Milton G. Kofskey, Theodore Katsanis, Richard J. Roelke, Kerry L. McLallin & Robert Y. Wong
Karl Kramer
Lawrence P. Ludwig & Thomas N. Strom
T. F. Lyon
(General Electric Co.)

Ronald J. Schertler, Robert A. Mueller, Russel J. Jirberg, Dale W. Cooper, John E. Heighway, A. David Holmes, Richard T. Gedney & Herman Mark
James F. Sellers & Carl J. Daniele
F. S. Stepka & D. Poferl
Marvin Warshay, Lyle O. Wright & Lawrence A. Thaller

Marshall Space Flight Center

Robert L. Brown

Paul S. Buckmann
(Aerojet Liquid Rocket Co.)

S. V. Caruso, D. L. Kinser, S. M. Graff & R. V. Allen
Salvadore V. Caruso & J. O. Honeycutt
William C. Cliff & Virgil A. Sandborn

James J. Cowan
(National Academy of Sciences)

R. F. Currier & W. L. Palmer
(Lockheed Missiles & Space Co., Inc.)

John H. Dawson & Adolph F. Brux
(Rockwell Intl. Corp.)

A. Deepark, R. Ozarski & J. A. L. Thomson

Murray J. Dinkins
(General Electric Co.)

A. P. Divecha
(Commonwealth Scientific Corp.)

George S. Evans
(Westinghouse Electric Corp.)

A. Feller, A. Smith, P. Radmondetta, R. Noto, & T. Lombardi
(RCA Corp.)

Joseph F. Froechtenigt
(Martin Marietta Corp.)

Robert A. Gange

Robert R. Gange & Carl C. Steinmetz
(RCA Corp.)

Willard A. Gillon, Jr., & Gilbert F. Tellier
(Rockwell Intl. Corp.)

R. C. Gonzalez & Barry A. Fittes
(University of Tennessee)

Raymond K. Hart
(Ga. Institute of Technology)

C. A. Harvey & Y. S. Lee
(Honeywell, Inc.)

Douglas R. Hendler
(McDonnell Douglas Corp.)

Robert H. Henry & Owen K. Olsen
(Rockwell Intl. Corp.)

Dennis B. Heppner & Sedwick O. Atwood
(General Dynamics Corp.)

Charles E. Hoffman
(Rockwell Intl. Corp.)

Alvis M. Holladay & Carl T. Huggins
Robert M. Huffaker
Edwin E. Klingman III

W. E. Kohman
(Perkin-Elmer Corp.)

Raoul W. Lopez, Jerold L. Vaniman & Robert R. Fisher

Ray E. Marlow
(Sperry Rand Corp.)

R. S. Mezrich
(RCA Corp.)

T. K. Mookherji & J. D. Hayes
(Teledyne Brown Engineering)

K. L. Perkins & J. J. Licari
(Rockwell Intl. Corp.)

Palmer N. Peters

Frank L. Rosenthal
(Rockwell Intl. Corp.)

John A. Sanders
(Martin Marietta Corp.)

Phillip J. Stocker & Harris L. Marcus
(Rockwell Intl. Corp.)

J. Gethyn Timothy
(Harvard College Observatory)

J. Gethyn Timothy (Harvard) &
Richard L. Bybee (Ball Bros. Research)

John E. Turnage, Rodeny M. F. Linford & Steve D. Cornish
(McDonnell Douglas Corp.)

Anthony O. Ukanwa
(Howard University)

H. U. Walter, L. A. Weitzenkamp, & P. N. Peters
David J. Winslow

Gary L. Workman
(Athens College)

Joseph A. Zelik
(McDonnell Douglas Corp.)

James M. Zwiener

Pasadena Office, Calif., & Caltech

Tage O. Anderson
Walter H. Anderson & Dominic A. Costanza
Maurice J. Argoud, Jack Jolley & Walter L. Walker
Ralph E. Bartera & Charles G. Miller
Richard H. Burns & Louis F. Schmidt

Robert P. Carpentier, Johannes P. Pietrzyk, Rolf R. Beyer & Jerome S. Kalafut
(Westinghouse Electric Corp.)

Cyril Feldstein, Gilbert W. Lewis, Robert H. Silver & Virgil H. Culler
Fred T. Krogh
George W. Lewicki
Lewis P. Leibowitz
Charles G. Miller & James B. Stephens
Marvin Perlman
Phil M. Salomon & Louis F. Schmidt
Rudolf A. Schindler (2 awards)
Raymond C. Woodbury
Robert K. Yasui

Are you getting your **1 cent** worth from **NASA**?

For a penny of your tax dollar,
you are getting, among other things

A Weight-relieving Invention for Patients in Therapy

A device originally used for training Apollo astronauts has been adapted by researchers at NASA's Langley Research Center as an aid to persons who cannot support their entire weight with their legs. A constant part of the weight of a patient is supported during rehabilitation exercises by a combination of multiple pulleys and spring clusters, which are used in conjunction with a cammed wheel pulley to create a constant force over a specified operating range. The support harness provides the means for the user to shift pressure from hands to armpits to crotch as dictated by comfort and personal preference.

The device, called in space research the Langley Flying Lunar Excursion Experimental Platform, exerts a constant weight-relieving force during any vertical movement by the patient, including walking, stooping, squatting, moving from a sitting to a standing position, or climbing stairs. The supporting force is preselected for a particular patient and can be changed from one value to another as the patient's condition improves.

The constant-value weight-relieving apparatus supports a patient under the arms, at the hands, under the sea and around the upper legs. The crutches do not rest on the floor, so the patient's weight, other than the constant force, is supported by his legs. If the patient should begin to fall, the cammed pulley is contoured to bring him to a smooth stop before he strikes the floor. Therapists believe that shorted crutches also may add confidence inasmuch as their presence seems to help relieve fear of falling.

The patient exercises by walking back and forth under the framework. The overhead supporting mechanism is either towed along by the supporting strap or moves at a speed selected by the therapist to lag behind, to match the movement dictated by the patient's condition, or to lead the patient slightly. Use of a selected speed motor and a gear box relieves the requirement for the patient to overcome the initial inertia and weight drag of the apparatus.

In a modification of the supporting harness, flexible straps are used in place of the crutches to enable a person to don the harness while in a sitting position.

Industrial applications of the device also have been suggested for locations such as warehouses and equipment is handled, particularly shock-sensitive equipment and instrumentation.

NASA

National Aeronautics and
Space Administration

"For the benefit of all . . ."